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THE POSITIONS OF THE BAKER-NUNN CAMERA STATIONS

by

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THE POSITIONS OF THE BAKER-NUNN CAMERA STATIONS

by

George Veis[1]

An attempt has been made to reduce the coordinates of the Baker-Nunn camera stations to a uniform geodetic system (datum) based on the international ellipsoid.

To transform the positions from one geodetic system to another, when the relative deflection of the vertical and the parameters of the reference ellipsoids are known, we did not use the classical method suggested by Helmert or that of Vening Meinesz (1950), which employ the elliptical coordinates (ϕ and λ). Instead, we developed a new method using rectangular coordinates. This method is much simpler and is valid for any distance between the two systems to be connected.

First, the stations were connected to the major geodetic systems by standard geodetic methods -- triangulation, traverse, levelling. Whenever geoidal heights were available, they were taken into account in order to reduce the elevations above sea level (the geoid) to those above the reference ellipsoid of the system. Most of the material concerning geoidal heights was obtained from Fischer (1959).

These coordinates have been transformed into geodetic rectangular coordinates[2] in the same geodetic system where they were originally determined.

[1]Consultant, Smithsonian Astrophysical Observatory; now at National Technical University, Athens, Greece.

[2]X-axis on the equator parallel to the meridian of Greenwich, Y-axis on the equator in a right angle with the X-axis and toward India, Z-axis parallel to the mean polar axis.

The absolute deflection of the vertical in meridian (ξ) and in prime vertical (η), as determined from different methods and sources, was taken into account for every geodetic system employed. The following values have been used:

North American	ξ = -1".3	η = +0".3	(Rice; see Heiskanen, 1950)
European	+3".36	+1".78	(Bomford; see Heiskanen, 1950)
Japanese	-12".6	+17".5	(Hirose, 1956)
Australian	+1".6	+10".8	(unpublished)[3]

Zero deflection of the vertical was assumed in the Argentinian system.

The above deflections, rotated on the rectangular displacement along the X-, Y-, and Z-axes (Veis, 1960, p. 101) gave the following results (in meters):

	X	Y	Z
North American	-5	+26	+31
European	+93	-35	-63
Japanese	+520	+265	+315
Australian	+183	+276	-41
Argentinian	0	0	0

To this displacement we had to add a second displacement in order to reduce the systems to the international ellipsoid, keeping the condition of tangency at the origin. Obviously, this second displacement was not needed for the European and the Argentinian systems which are directly on the international ellipsoid.

The addition of these displacements to the original geodetic rectangular coordinates yields the rectangular coordinates which refer to a uniform system, as shown in Table 1.

[3] Letter from the Department of Supply, Weapons Research Establishment, Australia, 1959.

TABLE 1

RECTANGULAR DISPLACEMENTS OF THE
BAKER-NUNN CAMERA STATIONS

Station		Rectangular coordinates (in Mm)		
No.	Location	X	Y	Z
9001	Organ Pass	-1.535732	-5.167226	3.401154
9002	Olifantsfontein	5.056291	2.716562	-2.775723
9003	Woomera	-3.983755	3.743360	-3.275700
9004	San Fernando	5.105755	-0.555125	3.769798
9005	Tokyo	-3.946681	3.366587	3.698891
9006	Naini Tal	1.018286	5.471276	3.109564
9007	Arequipa	1.942731	-5.804282	-1.796795
9008	Shiraz	3.377040	4.404061	3.136326
9009	Curacao	2.251817	-5.817129	1.327264
9010	Jupiter	0.976289	-5.601610	2.880356
9011	Villa Dolores	2.280352	-4.914876	-3.355480
9012	Maui	-5.466148	-2.404268	2.242482

The rectangular coordinates given in Table 1, when transformed back to elliptical coordinates, with the international ellipsoid always as a reference, give the results that appear in Table 2.

TABLE 2

ELLIPTICAL COORDINATES OF THE BAKER-NUNN CAMERA STATIONS

Station				Elevation (meters) above	
No.	Location	Latitude	Longitude (E)	MSL	Reference ellipsoid
9001	Organ Pass	32°25'26".7	253°26'51".8	1651	1641
9002	Olifantsfontein	-25 57 34.7	28 14 51.1	1544	1466
9003	Woomera	-31 06 06.7	136 46 54.9	162	158
9004	San Fernando	36 27 49.8	353 47 41.5	24	49
9005	Tokyo	35 40 23.6	139 32 06.9	58	59
9006	Naini Tal	29 21 32.5	79 27 25.3	1924	1783
9007	Arequipa	-16 27 52.8	288 30 20.6	2451	2380
9008	Shiraz	29 38 15.6	52 31 08.3	1596	1520
9009	Curacao	12 05 27.9	291 09 41.3	7	-47
9010	Jupiter	27 01 16.6	279 53 11.8	12	-5
9011	Villa Dolores	-31 56 36.5	294 53 23.5	598	598
9012	Maui	20 42 36.1	203 44 31.7	3048	2992

The coordinates given here must be assumed to be of a tentative character. Their uncertainty should be about 100 to 150 meters, if we take into account the expected errors: a) in the geodetic connections, b) in the assumed deflections of the vertical, and c) in the assumed constants of the reference ellipsoid. When we have determined vertical values for the deflection of the vertical of the major systems and/or for the constants of the terrestrial ellipsoid, a new reduction will be made.

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NOTICE

This series of Special Reports was instituted under the supervision of Dr. F. L. Whipple, Director of the Astrophysical Observatory of the Smithsonian Institution, shortly after the launching of the first artificial earth satellite on October 4, 1957. Contributions come from the Staff of the Observatory. First issued to ensure the immediate dissemination of data for satellite tracking, the Reports have continued to provide a rapid distribution of catalogues of satellite observations, orbital information, and preliminary results of data analyses prior to formal publication in the appropriate journals.

Edited and produced under the supervision of Mrs. L. G. Boyd and Mr. E. N. Hayes, the Reports are indexed by the Science and Technology Division of the Library of Congress, and are regularly distributed to all institutions participating in the U.S. space research program and to individual scientists who request them from the Administrative Officer, Technical Information, Smithsonian Astrophysical Observatory, Cambridge 38, Massachusetts.

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